Dean, D. A. and W. L. Sterling. 1985. Size and phenology of ballooning spiders at two locations in eastern Texas. J. Arachnol., 13:111-120.

SIZE AND PHENOLOGY OF BALLOONING SPIDERS AT TWO LOCATIONS IN EASTERN TEXAS[1]

D. A. Dean and W. L. Sterling

Department of Entomology
Texas A&M University
College Station, Texas 77843

ABSTRACT

The aerial dispersal of spiders at two locations in eastern Texas was studied using a Johnson-Taylor suction trap. A total of 17,596 spiders were collected at College Station, Texas during a one year period, and 6248 spiders at the Ellis Unit from April to August. Nineteen families were found including Uloboridae and Hahniidae. The greatest numbers of spiders were collected during May and June at College Station with immatures representing 94% of total spiders collected during the year. The families Erigonidae, Araneidae, and Oxyopidae comprised ca. 74% of all spiders collected at College Station. The size class 1-2 mm represented 64% of all spiders collected at College Station with those < 1 mm in length next in abundance with 28%.

INTRODUCTION

Suction traps have been used to study the monthly dispersal of spiders in Oklahoma and Texas (Horner 1975, Salmon and Horner 1977). Ballooning spiders, captured in a Johnson-Taylor suction trap, peaked during June and September (Salmon and Horner 1977) and spiders in the family Erigonidae were reported to be the most numerous. Horner (1975) studied the dispersal of salticids in Oklahoma and found immatures peaking in July. Adult spiders were also observed to balloon.

Other workers used different methods to study dispersal. Glick (1939) collected ballooning spiders at different heights by airplane in Louisiana. The number of spiders collected was highest near the ground and lowest at 5000 ft. elevation. Freeman (1946), at a height of 3 m, used nets attached to masts to observe that spiders actively ballooned at all wind velocities ranging from 6-35 mph. More ballooning male spiders were present in September and October than any other month in England (Duffey 1956). Ballooning females were abundant over a longer period of time, from September to March. Bristowe (1929) observed that immatures of several families balloon in late summer and early autumn in England but as winter approaches, the proportion of linyphiids increases and the other families decrease.

Spiders are known to be predaceous and McDaniel and Sterling (1982) and McDaniel et al. (1981) determined those species of spiders which are predaceous on *Heliothis* spp. eggs and larvae in a cotton field in eastern Texas. Dean et al. (1982) listed the species of

[1] Approved for publication as TA *19150* by Director, Texas Agricultural Experiment Station.

spiders collected from the same cotton field. To eventually predict the phenology and abundance of spiders colonizing cotton fields, the seasonal profile of potential colonizing species should be known. The current study was conducted to determine the seasonal phenological profile of each spider family and the size most likely to balloon in eastern Texas. The dispersal of adults identified to species will be presented in a separate paper.

METHODS AND MATERIALS

A Johnson-Taylor suction Trap (Johnson and Taylor 1955) was used to study the aerial dispersal of spiders in eastern Texas. The cylindrical trap is 2.5 m tall and 55.8 cm in diameter. A cone-shaped fine mesh screen located in the trap funnels the spiders into a one pint jar of either 70% ethyl alcohol or 50% ethylene glycol. A 0.33 h.p. electric motor driven fan pulls air and spiders into the trap.

Two locations were used for sampling: at College Station, Texas from 26 March 1979 to 25 March 1980 and at the Ellis Unit of the Texas Department of Corrections from 3 April to 31 August 1980 (through the growing season). The College Station site was located next to the Entomology Research Laboratory on the Texas A&M University campus. The area is surrounded by paved streets, buildings, small cotton plots, natural vegetation, and trees. The Ellis Unit is located 8 km northeast of Huntsville, Texas. This site is on a flood plain of the Trinity River and surrounded predominantly by pinewoods. The trap was located in an area surrounded by pastures, silage, sorghum, and corn; the nearest cotton was ca. two km away. The trap was set at ground level at each location, and spiders ballooning at ca. 2.5 m in elevation were captured. Jars containing the samples were changed daily at College Station and daily when possible at the Ellis Unit. It is possible that large adult salticids may have crawled into the trap since a nest was occasionally seen near the top of the trap. However, adults [e.g. *Phidippus audax* (Hentz)] were observed attached to a drag line and being blown about by the wind.

Identification to the family level was recorded along with the life stage (adult/immature). No attempt was made to determine the instars, but each spider was assigned to an arbitrary size class (< 1 mm, 1-2 mm, etc.). The size was measured from the anterior of the carapace to the posterior of the abdomen, excluding the spinnerets.

RESULTS

A total of 17,596 spiders in 19 families were captured in the suction trap at College Station (hereafter, abbreviated as C.S.) during a one year period (Table 1). Most of the families have previously been reported to balloon. The Mysmenidae were included in the Theridiidae but are currently considered to be a separate family (Platnick and Shadab 1978).

Spiders were captured in the trap every month of the year, but the highest catches were recorded in June and September. Most of the spiders were immature (94.0%). More adult males (4.4%) were captured than adult females (1.6%). The size class 1-2 mm represented 64.1% of all spiders collected. Other size classes included < 1 mm (28.1%), 2-3 mm (6.1%), 3-4 mm (1.0%), 4-5 mm (0.3%), and > 5 mm (0.4%).

Most (84%) of the spiders at C.S. were captured between May and October. Salmon and Horner (1977) found a similar pattern at Wichita Falls, Texas. Collections made during the winter months of January through March comprised 2.7% of the total yearly collection at C.S. compared to 1.7% at Wichita Falls.

Table 1.–Ballooning spiders collected at College Station, Texas (26 March 1979-25 March 1980).

	Month													
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	% of Total
Erigonidae	29	24	80	276	723	1277	803	587	1187	623	274	92	5975	34
Araneidae	7	12	39	216	947	1051	625	726	735	112	99	49	4618	26
Oxyopidae	16	16	25	4	37	137	74	268	927	361	394	148	2407	14
Tetragnathidae	18	19	10	204	448	369	226	93	208	129	73	26	1823	10
Lycosidae	17	11	8	13	19	40	65	110	392	46	63	30	814	5
Theridiidae	2	8	8	7	29	43	55	86	169	58	63	30	558	3
Salticidae	2	9	6	7	13	52	30	40	67	22	27	14	289	2
Thomisidae	3	8	14	10	14	34	13	16	33	47	48	39	279	2
Philodromidae	13	16	24	9	17	12	29	36	33	11	20	49	269	1
Dictynidae	2	1	2	1	–	5	16	35	32	26	25	14	159	<1
Linyphiidae	5	1	12	5	9	17	10	14	33	13	20	6	145	<1
Clubionidae	1	1	3	–	5	5	8	16	25	6	28	2	100	<1
Anyphaenidae	1	1	2	3	2	6	6	13	27	6	8	3	78	<1
Mysmenidae	–	–	–	–	1	2	–	10	5	2	3	–	23	<1
Mimetidae	–	–	–	–	–	–	1	4	9	1	6	1	22	<1
Gnaphosidae	–	1	2	8	6	–	3	–	–	–	–	–	20	<1
Uloboridae	–	–	–	–	–	–	1	2	5	3	2	–	13	<1
Pisauridae	1	–	–	–	–	–	–	–	1	–	–	1	3	<1
Hahniidae	–	–	–	–	–	1	–	–	–	–	–	–	1	<1
Total	117	128	235	763	2270	3051	1965	2056	3888	1466	1153	504	17596	

At the Ellis Unit 6248 spiders were captured during the growing season (April-August). The same families found at C.S. were also found at Ellis (Table 2). A lower number of immatures was found at this location (83.0%) and adult males (9.3%) slightly outnumbered adult females (7.7%). The distribution of size classes was as follows: < 1 mm (21.8%), 1-2 mm (66.4%), 2-3 mm (6.5%), 3-4 mm (2.5%), 4-5 mm (1.4%), and > 5 mm (1.4%). Peak dispersal occurred during May.

In the < 1 mm size class, the three most abundant families at each location were the Araneidae, Erigonidae, and Tetragnathidae. The Erigonidae and Araneidae were among the most abundant families in the 1-2 mm class (Fig. 1). The most abundant families in the 2-3 mm and > 5 mm classes varied between locations. Although not shown in Fig. 1, the 3-4 mm and 4-5 mm size classes were dominated by the Salticidae.

Spiders captured in the suction trap may not accurately represent the total ballooning fauna since it collected only those ballooning at the 2.5 m altitude. However, Glick (1939) reported that spiders were most abundant close to the ground. Other factors such as amount of silk, wind, habitat, and time of day may affect the ballooning fauna so to sample the entire spider fauna may require the use of several sampling techniques simultaneously.

The Erigonidae and Tetragnathidae are subfamilies of the Linyphiidae (Millidge 1980) and Araneidae (Levi 1980), respectively, but are raised to the family level here for greater detail and for comparisons to the study by Salmon and Horner (1977).

Family Dispersal at C.S.—*Erigonidae:* One-third (34%) of the spiders collected belong to this family (Table 1). The size class < 1 mm comprised 17.3% of the erigonids and peaked in June whereas those > 1 mm (1-2 mm, 80.8%) remained abundant from May to October. Males peaked in September (20.1% of male erigonids) and females peaked in August (17.0%). Adults comprised 12.2% of total erigonids.

Araneidae: The most numerous size class of araneids was < 1 mm (57.0%) which peaked in June. Spiders > 1 mm (1-2 mm, 41.7%) remained abundant from May to September.

Oxyopidae: This family was most abundant during the fall. Most of the specimens collected were < 2 mm (86.7%) and were captured in September. A peak occurred in November for those > 2 mm. The 2-3 mm class contained 11.8% of the oxyopids and < 1 mm with 2.3%.

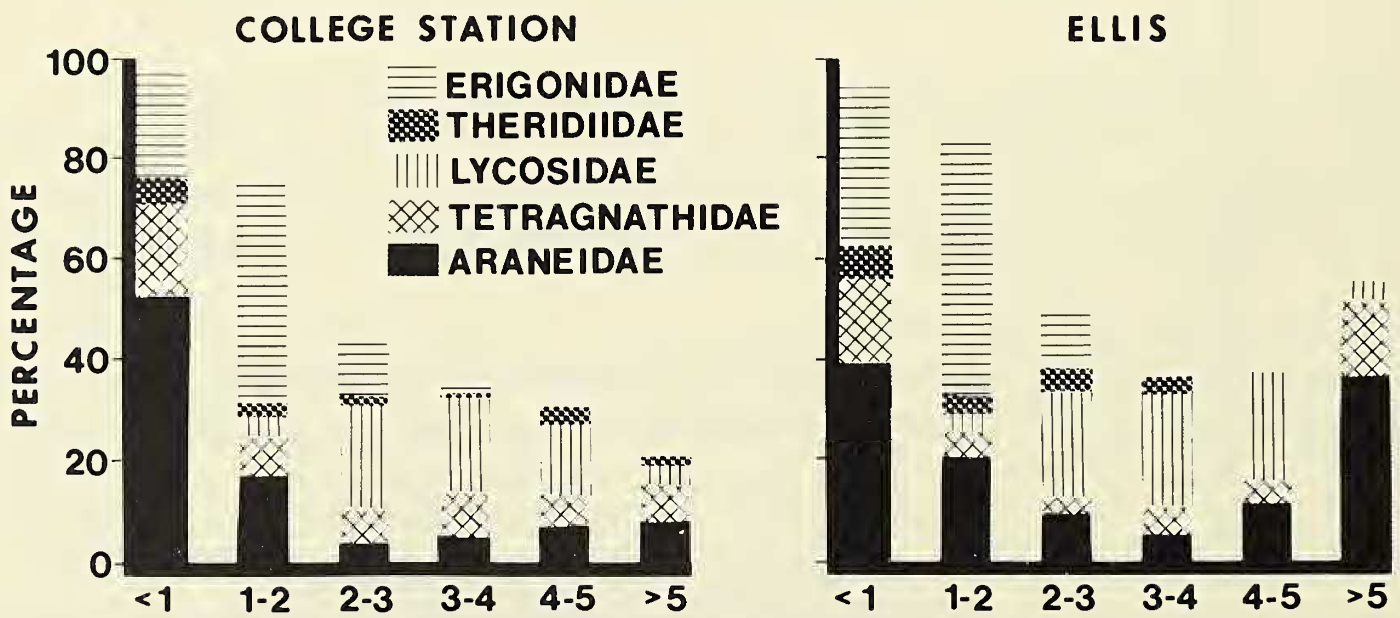


Fig. 1.—Percentages of the most abundant families of spiders collected in a suction trap at College Station and the Ellis Unit in Texas.

Tetragnathidae: This family was the fourth most abundant. Those spiders < 1 mm (49.9%) were the most numerous and peaked in May and June. Those > 1 mm (1-2 mm, 45.1%) also peaked in May.

Lycosidae: Nearly half (48%) of the lycosids captured ballooned in September. The size class 1-2 mm (66.3%) was most abundant in September. Those > 2 mm (2-3 mm, 27.9%) also peaked in September.

Theridiidae: The peak month was September for the size class < 1 mm (39.2%). Theridiids > 1 mm (1-2 mm, 56.8%) also peaked in September. Adults were most numerous in the trap in September with more males being captured than females.

Salticidae: The salticids 1-2 mm in length (46.0%) were most numerous in June. September was the peak month for the size class 2-3 mm (31.2%). The 3-4 mm class comprised 14.5%.

Thomisidae: Thomisids peaked during the fall months as did those in the size class 1-2 mm (77.4%) in October and November. The other classes were similar in abundance: < 1 mm (5.4%), 2-3 mm (7.5%), 3-4 mm and 4-5 mm (4.3% each).

Philodromidae: Like the previous family, the philodromids also peaked during the fall. The peak month for those < 2 mm (45.4%) was August, whereas December was the peak month for those > 2 mm (2-3 mm, 45.3%) in length.

Dictynidae: Dictynids were most numerous form August to November. Most of those 1-2 mm (73.0%) ballooned in August. The size classes < 1 and 2-3 mm comprised 13.8% and 13.2%, respectively.

Linyphiidae: September was the peak month for the 1-2 mm size class (89.0%) and for total linyphiids. The < 1 mm class represented 9.6%. Males and females were captured in similar numbers with a peak in September.

Table 2.—Ballooning spiders collected at Ellis (3 April-31 August 1980).

	Month						
	Apr.	May	June	July	Aug.	Total	% of Total
Erigonidae	380	1173	719	247	50	2569	41
Araneidae	111	483	297	516	79	1486	24
Tetragnathidae	37	173	90	119	38	457	7
Lycosidae	35	92	81	86	11	305	5
Thomisidae	19	21	53	152	19	264	4
Theridiidae	14	35	53	88	48	238	4
Dictynidae	3	8	9	119	98	237	4
Oxyopidae	15	22	38	81	27	183	3
Salticidae	79	32	12	27	19	169	3
Anyphaenidae	14	11	26	32	11	94	1
Linyphiidae	23	34	19	14	3	93	1
Philodromidae	8	10	16	9	7	50	1
Clubionidae	2	6	5	7	16	36	<1
Gnaphosidae	2	12	7	3	2	26	<1
Mysmenidae	–	10	3	2	–	15	<1
Mimetidae	–	1	1	6	6	14	<1
Pisauridae	–	6	2	1	–	9	<1
Uloboridae	–	1	–	1	–	2	<1
Hahniidae	–	1	–	–	–	1	<1
Total	742	2131	1431	1510	434	6248	

Clubionidae: The clubionids tended to be more numerous during the fall. The most individuals were in the size class 1-2 mm (34.0%) which peaked in September. The second largest grouping were those > 5 mm (32.0%), peaking in November. The 2-3 mm class comprised 25.0%.

Anyphaenidae: August and September were the peak months for total anyphaenids and also for the size class 1-2 mm (50.0%). Other size classes included: 2-3 mm (19.2%), 3-4 mm (14.1%), 4-5 mm (5.1%), and > 5 mm (11.6%).

Mysmenidae: All mysmenids captured were < 1 mm. Most were collected during the fall.

Mimetidae: In this study, 22 mimetids were collected from July to December. Salmon and Horner (1977) reported finding only one mimetid. The size class 1-2 mm contained 63.6% of the total. The other size classes were ca. evenly distributed. No males were captured but females were collected in September, November and December.

Gnaphosidae: Gnaphosids were captured mainly in April and May with the 2-3 mm size class containing 80.0% of the total (1-2 mm, 20.0%).

Uloboridae: This may be a new record, as we have not seen a previous report of this family ballooning. Thirteen specimens were collected from July to November. One male was captured in September. The most individuals were in the 1-2 mm class (61.5%).

Pisauridae: Three pisaurids were collected.

Hahniidae: This also appears to be a new record for ballooning activity. One specimen was taken in June. Duffey (1956) reported that *Hahnia nava* Bl. was common in England but did not disperse by aerial means.

Size Dispersal.—The percentages by size of six of the most common spiders (where the immatures could be identified) collected in a suction trap (adults and immatures included) are presented in Figure 2. The most individuals of *Acanthepeira stellata* (Walckenaer) (As) at C.S. were in the size class 1-2 mm which peaked in September. Those > 5 mm (all males, $\bar{x}$ = 6.9 mm) were captured in September. The size class 1-2 mm at Ellis included the most individuals in July. This was also the peak month for those > 5 mm (all males, $\bar{x}$ = 8.4 mm). Over 85% of the total at each location were in the 1-2 mm size class.

Gea heptagon (Hentz) (Gh) was not very numerous at C.S. but the size classes < 1 and 1-2 mm included the most individuals which were collected mostly from August to

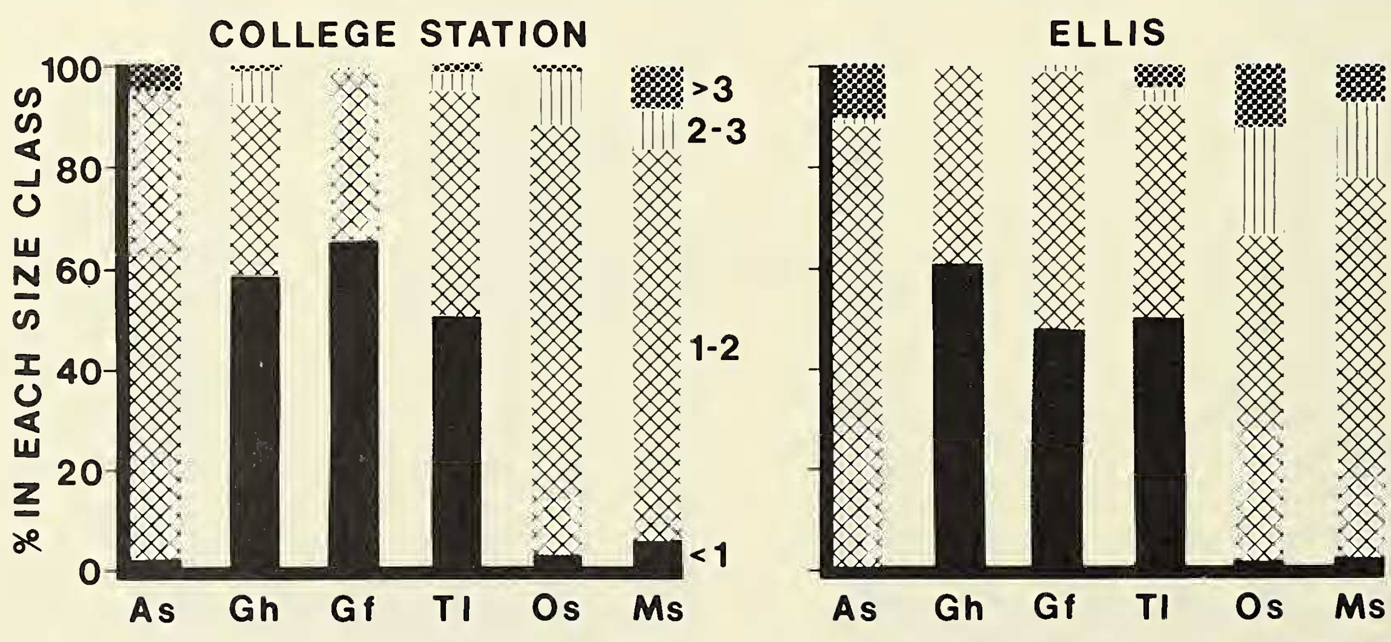


Fig. 2.—Distribution of the most abundant species by size class at College Station and the Ellis Unit in Texas. (As = *Acanthepeira stellata,* Gh = *Gea heptagon,* Gf = *Glenognatha foxi,* Tl = *Tetragnatha laboriosa,* Os = *Oxyopes salticus,* and Ms = *Misumenops* spp.).

December. More individuals were collected at Ellis where these two size classes peaked in July. About 60% of the total at each location were < 1 mm in size. Most of the remaining spiders were in the 1-2 mm size class.

The most numerous species at C.S. was *Glenognatha foxi* (McCook) (Gf) with most individuals in the smaller size class, < 1 mm, being captured in May and June. August and September was the peak period for the 1-2 mm size class. June was the peak month at Ellis for these size classes. Most of the individuals of *G. foxi* belonged in these two size classes. Adult males ($\bar{x}$ = 1.7 mm) were most abundant in September at C.S. and May at Ellis. One adult female ($\bar{x}$ = 2.2 mm) was collected in April at each location.

Tetragnatha laboriosa Hentz (Tl) was the third most abundant species at C.S. The size classes < 1, 1-2, and 2-3 mm peaked in May and June. May was also the peak month at Ellis for the size classes < 1 and 1-2 mm. About 50% of the total at each location were < 1 mm. This size class corresponds to the second instar stage that emerges from the egg sac ready to disperse (LeSar and Unzicker 1978). Few adults were collected ($\bar{x}$ of males = 5.5 mm at C.S. and 8.0 mm at Ellis; $\bar{x}$ of females = 9.2 mm).

Oxyopes salticus Hentz (Os) was the second most abundant species at C.S. with the size classes < 1 and 1-2 mm peaking in September. Those 2-3 mm in size peaked in November. The numbers at Ellis were much lower with the size classes 1-2 mm to 4-5 mm peaking in July. Several males were collected with a $\bar{x}$ of 4.4 mm at C.S. and 4.7 mm at Ellis.

Misumenops spp. (Ms) were collected in similar numbers at each location with those spiders 1-2 mm in size the most numerous (ca. 75% of the total). The 1-2 mm size class peaked in October. The size classes 1-2 mm to 3-4 mm at Ellis peaked in July. Four males were collected at each location ($\bar{x}$ = 3.5 mm). Two females at Ellis measured 7.2 mm in length.

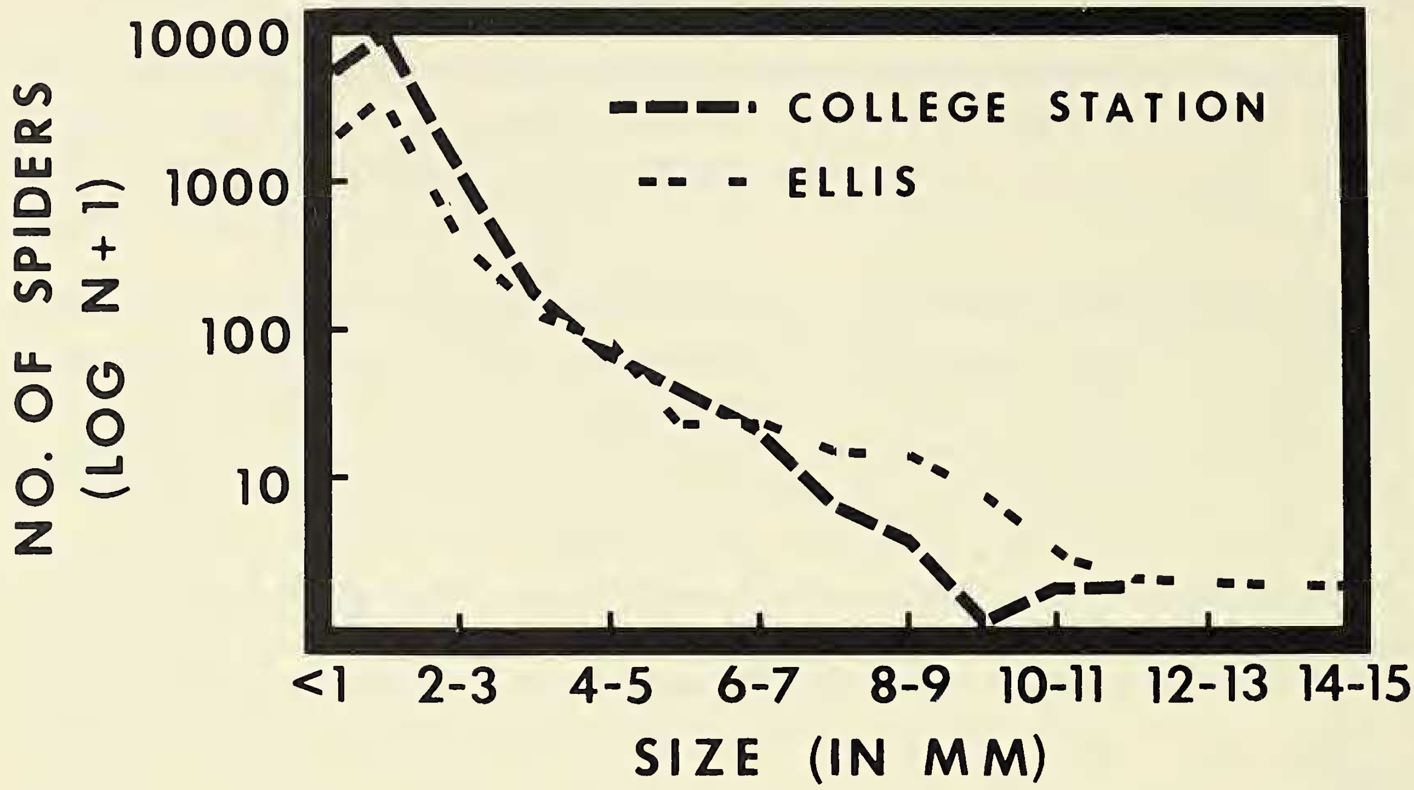
DISCUSSION

It is well known that immature spiders disperse when they emerge from the egg sac, primarily to avoid the cannibalistic tendencies of their siblings and to increase survival chances by avoiding overcrowding (Turnbull 1973). "It is usually, but not invariably, very young spiders that exhibit the aeronautic habit" (Comstock 1948). Horner (1975) reported that 88% of the salticids collected in a Johnson-Taylor suction trap were immature (mostly early instar). Salmon and Horner (1977) stated that size is one of the major restrictions to ballooning. Richter (1970) observed that aerial dispersal occurs generally in young instars of eight *Pardosa* species, though different species have different dispersal capacities.

These observations suggest that smaller species of spiders tend to balloon more frequently than larger species and that early instars balloon more than later instars. Smaller spiders, such as the erigonids, are caught ballooning more frequently than larger spiders in other families. However, without knowing the relative abundance of individuals in these families, the conclusion that small spiders balloon more readily than large spiders is questionable. Obviously, we see a dramatic reduction in numbers of individuals correlated with increasing size classes (Fig. 3). But, do spiders in earlier instars within a taxon balloon more often than later instars?

We suggest that in nature some species exhibit little or no difference in the ballooning rates of the various sizes and the difference in numbers of individuals in the various size classes may largely represent normal mortality; i.e. mortality of the young result in fewer

Fig. 3.—Numbers of spiders in their respective size ranges captured in a suction trap at College Station and the Ellis Unit in Texas.



large individuals rather than reduced ballooning behavior in these later instars. In Table 3 we suggest that the number collected in each size class compared to the class with the most individuals may represent percent survival. For example, at C.S. from the class containing the greatest number of individuals of a species to the 4-5 mm class the survival of *Tetragnatha laboriosa* would be 0.4%, *Oxyopes salticus* 0.3%, *Chiracanthium inclusum* (Hentz) 12.0%, and *Misumenops* spp. 5.9%. In the long term the average number of adults which must survive from the eggs deposited by a single female must be two (1 male and 1 female) for the population density to remain stable from year to year. Thus, for *C. inclusum*, which averages ca. 76 eggs per female (Peck and Whitcomb 1970), survival of 12.0% of the ballooning stages to the 4-5 mm size class leaves ca. 9.1% additional generation mortality which can take place before 2.9% of the generation remains. This lower survival rate is equal to 1 male and 1 female or an Ro (increase per female per generation) of one. However, Peck and Whitcomb (1970) found ca. 10% mortality form egg to first instar. This results in an Ro of ca. 4.1. *Misumenops* spp. was calculated to have an Ro of 14.0 based on data from Muniappan and Chada (1970). Early mortality of *O. salticus* and *T. laboriosa* would leave them with an Ro of ca. 1.0. Since *O. salticus* and *T. laboriosa* appear to have a lower survival rate but are more abundant in the suction trap and in cotton (Dean et al. 1982) than *C. inclusum*, numbers in the trap in this study do not appear to indicate equal ballooning rates among size classes.

Definitive tests of a hypothesis that instars balloon at equal rates should be based on field collections by species and by classifying individuals into instars. Then with season-long suction trap samples the yearly survival rates could be estimated and year to year trends in population dynamics of various species could be more accurately determined.

Other factors that could influence the results of this experiment are: (1) the efficiency of the suction trap in collecting various sizes of spiders, (2) elevation preference of ballooning individuals of the various instars within a species, (3) ballooning time of individuals in different size classes, and (4) actual mortality in the field.

Table 3.–Percentage survival from the size class with the most individuals to the other size classes captured in a suction trap at College Station, Texas.

	Size		class in mm	(n)	% survival
Tetragnatha laboriosa	<1	(909) to	1-2	(823)	90.5
			2-3	(66)	7.3
			3-4	(16)	1.8
			4-5	(4)	0.4
			>5	(5)	0.5
Oxyopes salticus	1-2	(2022) to	2-3	(257)	12.7
			3-4	(23)	1.1
			4-5	(6)	0.3
			>5	(2)	0.1
Chiracanthium inclusum	1-2	(25) to	2-3	(24)	96.0
			3-4	(4)	16.0
			4-5	(3)	12.0
			>5 imm.	(19)	76.0
			>5 ad.	(13)	52.0
Misumenops sp.	1-2	(186) to	2-3	(18)	9.7
			3-4	(7)	3.8
			4-5	(11)	5.9
			>5	(3)	1.6

However, for certain species of spiders, the catch-frequency may represent expected abundance due to natural mortality rather than higher ballooning rates of smaller individuals. If this size frequency is due to natural mortality, then continuous suction trapping throughout the year may be used to obtain data useful in developing life tables and predicting the dynamics of spider populations.

Of the most abundant species collected during this study, most ballooned in more than one size class and many ballooned as adults. Thus, Comstock (1948) may be correct in stating that it is usually young spiders that exhibit the aeronautic habit. However, our data provide evidence that two other factors should be considered: (1) differential rates of ballooning between instars and (2) age dependent survivorship.

ACKNOWLEDGMENTS

We appreciate the cooperation of Billy Moore and Joe Berry of the Texas Department of Corrections. The authors thanks Mrs. Pebble Lewis for assistance with sorting of some samples and Norman Horner for use of the suction trap. We thank Lynn Carroll and Gregg Nuessly for their review of this manuscript.

This research was supported in part by the National Science Foundation and the Environmental Protection Agency through a grant (NSF GB 34718) to the University of California and Texas A&M University. Continued support has been provided by EPA grant no. R-806277-01 and the Texas Agricultural Experiment Station under project H-2591. This research was conducted in cooperation with SEA, USDA, and the Texas Department of Corrections.

LITERATURE CITED

Bristowe, W. S. 1929. The distribution and dispersal of spiders. Proc. Zool. Soc. London, 43:633-657.

Comstock, J. H. 1948. The Spider Book. Doubleday & Co., New York, rev. by W. J. Gertsch, 729 pp.

Dean, D. A., W. L. Sterling and N. V. Horner. 1982. Spiders of eastern Texas cotton fields. J. Arachnol., 10:251-260.

Duffey, E. 1956. Aerial dispersal in a known spider population. J. Anim. Ecol., 25:85-111.

Freeman, J. A. 1946. The distribution of spiders and mites up to 300 feet in the air. J. Anim. Ecol., 15:69-74.

Glick, P. A. 1939. The distribution of insects, spiders, and mites in the air. United States Dept. Agric. Tech. Bull. 673, 150 pp.

Horner, N. V. 1975. Annual aerial dispersal of jumping spiders in Oklahoma (Araneae, Salticidae). J. Arachnol., 2:101-105.

Johnson, C. G. and L. R. Taylor. 1955. The development of large suction traps for airborne insects. Ann. Appl. Biol., 43:51-61.

LeSar, C. D. and J. D. Unzicker. 1978. Life history, habits, and prey preferences of *Tetragnatha laboriosa* (Araneae: Tetragnathidae). Environ. Entomol., 7:879-884.

Levi, H. W. 1980. The orb-weaver genus *Mecynogea,* the subfamily Metinae and the genera *Pachygnatha, Glenognatha* and *Azilia* of the subfamily Tetragnathinae North of Mexico (Araneae: Araneidae). Bull. Mus. Comp. Zool., 149:1-74.

McDaniel, S. G. and W. L. Sterling. 1982. Predation of *Heliothis virescens* (F.) eggs on cotton in east Texas. Environ. Entomol., 11:60-66.

McDaniel, S. G., W. L. Sterling and D. A. Dean. 1981. Predators of tobacco budworm larvae in Texas cotton. Southwest. Entomol., 6:102-108.

Millidge, A. F. 1980. The erigonine spiders of North America. Part 1. Introduction and taxonomic background (Araneae: Linyphiidae). J. Arachnol., 8:97-107.

Muniappan, R. and H. L. Chada. 1970. Biology of the crab spider, *Misumenops celer.* Ann. Entomol. Soc. America, 63:1718-1722.

Peck, W. B. and W. H. Whitcomb. 1970. Studies on the biology of a spider, *Chiracanthium inclusum* (Hentz). Arkansas Agric. Exp. Stn. Bull. 753, 76 pp.

Platnick, N. I. and M. U. Shadab. 1978. A review of the spider genus *Mysmenopsis* (Araneae, Mysmenidae). American Mus. Novit., 2661:1-22.

Richter, C. J. J. 1970. Aerial dispersal in relation to habitat in eight wolf spider species (*Pardosa,* Araneae, Lycosidae). Oecologia, 5:200-214.

Salmon, J. T. and N. V. Horner. 1977. Aerial dispersion of spiders in North Central Texas. J. Arachnol., 5:153-157.

Turnbull, A. L. 1973. Ecology of the true spiders (Araneomorphae). Annu. Rev. Entomol., 18:305-348.

Manuscript received November 1983, revised August 1984.